

MS-I Program Progress Report
for

NASA, George C. Marshall Space
Flight Center

Contract: NAS 8-5490

Hy-Cal W.O. 64-123

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Hy-Cal Engineering

SANTA FE SPRINGS, CALIFORNIA

Program Progress Report

LOW LEVEL PURGED RADIOMETERS

Hy-Cal W. O. 64-123

This Report Covers the Months of:

October 31, 1964
November 30, 1964
December 31, 1964

for

NASA, George C. Marshall Space Flight Center

Contract: NAS 8-5490

Submitted by:

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INTRODUCTION

The following pages re-cap the program from September 30, 1964, to date, a three month period.

A critical design review was held at Hy-Cal Engineering January 11 and 12, 1965. Attending from NASA were C. M. Rhodes and W. T. Powers. Representing Hy-Cal Engineering in the meeting were R. A. Whitmore, B. Rappaport, and D. R. Hornbaker. The minutes of the meeting, which are attached, report the progress of the program, the testing, and the research which took place during September, October, and November, 1964.

The yellow page of the report is a list of action items. Certain questions must be answered and some decisions made before Hy-Cal can proceed. Hy-Cal will appreciate receiving in reply a wire from NASA just as soon as possible.

Because of the decisions which need to be made, an extension of the contract dates is requested.

CRITICAL DESIGN REVIEW

The Critical Design Review was convened on Monday morning, January 11, 1965. After a brief introduction, a complete review of the program-to-date was conducted. The first Task of the program, a consideration of a multiple Asymptotic® sensor, was described and the conclusions reached by Hy-Cal were reiterated. The second Task of the program, the use of the Hy-Cal Hy-Thermtm sensor concept, was then described. It was noted that the Hy-Thermtm sensor had been shown to meet the general requirements of the low level radiometer under study. However, during previous discussions between Hy-Cal and NASA personnel, it had been agreed that the response time characteristics of the Hy-Thermtm were not as good as might be desired and further studies were, therefore, to be conducted with the goal of obtaining a sensor with output characteristics comparable to the Hy-Thermtm, yet having faster response time characteristics. The remainder of the discussion was centered around Task 3, the development of a fast response sensor as noted above.

Hy-Cal Engineering was pleased to announce the completion of test units which exhibited the output characteristics and response time characteristics which had been the goal of the Task 3 effort. The new sensor, designated as the Hy-Therm-H, has been shown to have output characteristics far surpassing those required for the low level radiometer under consideration. A description of the Hy-Therm-H was presented by Hy-Cal and a discussion of the sensing concept was conducted. It was pointed out that the principles of operation for this sensor are identical to those of the standard Hy-Cal Asymptotic® rapid response calorimeter, and that the breakthrough made in the current design was one of miniaturization and geometrical modifications such that numerous sensors could be placed in a very small area, thus providing a multi-sensor instrument having a very small overall configuration. Following this discussion, the meeting was adjourned to the laboratory for calibration and gas purge demonstrations.

CALIBRATION

1. A demonstration was given of the calibration of a high output unit which would be capable of usefulness for the 1, 2, and 5 Btu/ft²-sec. ranges required for the low level radiometer. The unit was calibrated continuously between 0 and 1 Btu/ft²-sec and produced approximately 98 millivolts at 1 Btu/ft²-sec.

2. The linearity of the resulting curve was measured and found to be better than 1%, which is well within the requirements of this instrument.
3. The methods of calibration of this type instrument were described and discussed in detail with the NASA personnel. It was agreed that the methods used were correct.
4. A response time test was conducted on the instrument. The response time measured was approximately 375 milliseconds. This value is, again, well within the requirements of the low level radiometer and far surpasses original expectations.
5. The sensitivity of the unit was further demonstrated by subjecting the unit to heat from such items as a human hand and a cigarette, in which case the unit produced in excess of 5 millivolts.
6. Copies of all test data were supplied to those in attendance.
7. It was agreed that the output characteristics of the sensor developed fully meet the instrument requirements in the areas of linearity, response time, output voltage, and overall size.
8. NASA personnel expressed enthusiasm over the characteristics which have been demonstrated.

PURGE TEST DEMONSTRATION

A demonstration was given of the gas purge configuration planned for use on the low level radiometer. The test was conducted as follows:

1. Gas purge was attained using nitrogen with a flow rate of 3 to 4 cubic feet per minute.
2. A pure acetylene flame, using a number 10 tipped torch and from 1 to 10 psi acetylene pressure, was used to produce a sooting condition.
3. The angle of incidence of the flame was varied from zero to 90°, in addition to varying the acetylene pressure.
4. Results of the test were that severe sooting of the surface surrounding the window was observed while the window itself remained free of contamination. Thus, it was demonstrated that the purging system was effective in protecting the radiometer window from severe sooting conditions.
5. The conditions under which this test was conducted were observed by the NASA personnel to be typical of flight conditions and were representative of, or more severe than, those conditions normally used by NASA in their laboratories for

the evaluation of such systems. It was agreed that the performance was as good or better than the conical purge currently used by NASA.

Upon completion of the demonstrations, the meeting was re-convened in the conference room to further discuss the test results and to discuss the design details. During the discussion of the test results, NASA personnel expressed the opinion that a major technological breakthrough had been made and that the sensor that has been developed appears to be a major step forward in the field of low level radiometry.

DESIGN

The general design of the radiometer was discussed with respect to giving the optimum configuration in conjunction with the required output characteristics. A sketch, previously supplied by NASA, and sketches supplied by Hy-Cal were reviewed. The major problem areas and significant features of the instrument were discussed in detail. The following are some of the major points covered.

1. Connector - The connector callout on the NASA drawing, Physical Sciences T102WM-8-4P, covers only one of the possible mounting configurations, namely weld mount. The difficulty of such a weld and other possible methods of attachment were discussed. The final method of attachment was left open pending investigation of other possibilities by NASA personnel.
2. Resistance Patch - Per NASA request, a 500 ohm platinum resistance thermometer patch will be placed in the instrument. It was agreed that this seems to be a straightforward application and there were no points of concern, except that it was agreed that it could be placed in any convenient location within the heat sink.
3. Purge Gas Fittings - The method of attachment of the purge gas fitting was discussed. Two possible methods were suggested. One, a 1/8 inch pipe thread into the body and sealed with epoxy; and two, the fitting be brazed into the body. It was concluded that if there were no strong preferences on the part of NASA, Hy-Cal would prefer to make the decision on this method of attachment at a later date.
4. Mounting Holes - The NASA sketch calls for six holes equally spaced on a 1.82 diameter bolt circle. It was clarified that these holes are to be used for mounting the instrument and are not to be used for attaching any other item to the instrument.

The contract for Task 2 of this program was reviewed. Unlike Task 1, it does not call for approval of the prototype units before beginning fabrication of the additional 15 radiometers. If this is not the intent, NASA should advise Hy-Cal Engineering at the earliest possible date.

It is Hy-Cal's intention to finalize the detail design and, upon approval by NASA, proceed with production of prototypes. The drawings submitted will include a cross-section showing the detail design and outline configuration.

Since the program is at such a point in design that questions must be answered and designs approved prior to proceeding with fabrication, it is requested that the contract dates be revised as follows:

Delivery of three prototype units - March 15, 1965

*Shipment of the balance of units - April 15, 1965

Final Report - May 15, 1965

* See comment above regarding approval.

ACTION ITEMS

The following questions were brought up, and NASA is requested to supply answers at the earliest possible date:

1. Is Hy-Cal Engineering free to select the method of mounting the gas purge fitting? Unless otherwise stated by NASA, Hy-Cal will use the same purge fitting as supplied on the R-2006 radiometer previously supplied to NASA. A decision should be made by NASA as soon as possible on this item, because of the lead time required for purchasing of the fitting.
2. What mounting methods are acceptable for the Physical Sciences connector in addition to the weld mount as called out on the NASA sketch.
3. Is the outer body insulation around the 2 1/4" diameter bottom circumference and rear surface necessary?
4. Is phenolic acceptable as the outer body insulation where needed?
5. What is the maximum number of seconds of exposure time to the maximum heat flux?
6. Should an allowance be made for the cooling by the purge gas in the calculations for heat sink capacity?
7. It appears that the purge gas may cool the body faster than it will be heated by the full scale heat input to the front face of the instrument. What is the allowable design temperature rise for the heat sink body? This will influence the flange thickness.

The following is to be furnished by Hy-Cal Engineering:

1. Hy-Cal Engineering will furnish a suggested outline drawing for NASA's comments.